



Kwabena Boahen

Professor of Bioengineering and of Electrical Engineering

Bio

BIO

Boahen's research interests include mixed-mode multichip VLSI models of biological sensory and perceptual systems, their epigenetic development, and asynchronous digital communication for reconfigurable connectivity.

ACADEMIC APPOINTMENTS

- Professor, Bioengineering
- Professor, Electrical Engineering
- Member, Bio-X
- Member, Wu Tsai Neurosciences Institute

HONORS AND AWARDS

- NIH Director's Pioneer Award, National Institute of Health (2006)
- Young Investigator Program, Office of Naval Research (2002-present)
- Faculty Early Career Program, National Science Foundation (2001-present)
- Fellowships in Science and Engineering, Packard Foundation (1999-2004)

PROFESSIONAL EDUCATION

- PhD, Caltech (1997)

LINKS

- <http://bioengineering.stanford.edu/faculty/boahen.html>: <http://bioengineering.stanford.edu/faculty/boahen.html>

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Large-scale models of sensory, perceptual and motor systems

Teaching

COURSES

2017-18

- Biomedical System Prototyping Lab: BIOE 123 (Win)

- Neuromorphics: Brains in Silicon: BIOE 313, EE 207 (Spr)

2016-17

- Biomedical System Prototyping Lab: BIOE 123 (Win)
- Neuromorphics: Brains in Silicon: BIOE 313, EE 207 (Spr)

2015-16

- Biomedical System Prototyping Lab: BIOE 123 (Win)
- Neuromorphics: Brains in Silicon: BIOE 313, EE 304 (Spr)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Saurabh Vyas

Doctoral (Program)

Max Kanwal, Elise Robinson, Saarthak Sarup

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Biomedical Informatics (Phd Program)
- Neurosciences (Phd Program)

Publications

PUBLICATIONS

- **Braindrop: A Mixed-Signal Neuromorphic Architecture With a Dynamical Systems-Based Programming Model** *PROCEEDINGS OF THE IEEE*
Neckar, A., Fok, S., Benjamin, B., Stewart, T. C., Oza, N. N., Voelker, A. R., Eliasmith, C., Manohar, R., Boahen, K.
2019; 107 (1): 144–64
- **Optimizing an Analog Neuron Circuit Design for Nonlinear Function Approximation**
Neckar, A., Stewart, T. C., Benjamin, B. V., Boahen, K., IEEE
IEEE.2018
- **Live Demonstration: Optimizing an Analog Neuron Circuit Design for Nonlinear Function Approximation**
Neckar, A., Stewart, T., Benjamin, B., Boahen, K., IEEE
IEEE.2018
- **A Neuromorph's Prospectus** *COMPUTING IN SCIENCE & ENGINEERING*
Boahen, K.
2017; 19 (2): 14-15
- **A Population-Level Approach to Temperature Robustness in Neuromorphic Systems**
Kauderer-Abrams, E., Gilbert, A., Voelker, A., Benjamin, B., Stewart, T. C., Boahen, K., IEEE
IEEE.2017: 2723–26
- **Stochastic and Adversarial Online Learning without Hyperparameters**
Cutkosky, A., Boahen, K., Guyon, Luxburg, U. V., Bengio, S., Wallach, H., Fergus, R., Vishwanathan, S., Garnett, R.
NEURAL INFORMATION PROCESSING SYSTEMS (NIPS).2017
- **Extending the Neural Engineering Framework for Nonideal Silicon Synapses**
Voelker, A. R., Benjamin, B. V., Stewart, T. C., Boahen, K., Eliasmith, C., IEEE
IEEE.2017: 2086–89
- **Calibrating Silicon-Synapse Dynamics using Time-Encoding and Decoding Machines**
Kauderer-Abrams, E., Boahen, K., IEEE

IEEE.2017: 2525–28

- **Selective modulation of cortical state during spatial attention** *SCIENCE*
Engel, T. A., Steinmetz, N. A., Gieselmann, M. A., Thiele, A., Moore, T., Boahen, K.
2016; 354 (6316): 1140-1144
- **Neurogrid: A Mixed-Analog-Digital Multichip System for Large-Scale Neural Simulations** *PROCEEDINGS OF THE IEEE*
Benjamin, B. V., Gao, P., McQuinn, E., Choudhary, S., Chandrasekaran, A. R., Bussat, J., Alvarez-Icaza, R., Arthur, J. V., Merolla, P. A., Boahen, K.
2014; 102 (5): 699-716
- **A Multicast Tree Router for Multichip Neuromorphic Systems** *IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS I-REGULAR PAPERS*
Merolla, P., Arthur, J., Alvarez, R., Bussat, J., Boahen, K.
2014; 61 (3): 820-833
- **Potassium conductance dynamics confer robust spike-time precision in a neuromorphic model of the auditory brain stem** *JOURNAL OF NEUROPHYSIOLOGY*
Wittig, J. H., Boahen, K.
2013; 110 (2): 307-321
- **Design and validation of a real-time spiking-neural-network decoder for brain-machine interfaces.** *Journal of neural engineering*
Dethier, J., Nuyujukian, P., Ryu, S. I., Shenoy, K. V., Boahen, K.
2013; 10 (3): 036008-?
- **Design and validation of a real-time spiking-neural-network decoder for brain-machine interfaces.** *Journal of neural engineering*
Dethier, J., Nuyujukian, P., Ryu, S. I., Shenoy, K. V., Boahen, K.
2013; 10 (3): 036008-?
- **Dynamical System Guided Mapping of Quantitative Neuronal Models Onto Neuromorphic Hardware** *IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS I-REGULAR PAPERS*
Gao, P., Benjamin, B. V., Boahen, K.
2012; 59 (10): 2383-2394
- **Inferior olive mirrors joint dynamics to implement an inverse controller** *BIOLOGICAL CYBERNETICS*
Alvarez-Icaza, R., Boahen, K.
2012; 106 (8-9): 429-439
- **Neurogrid: A Mixed-Analog-Digital Multichip System for Large-Scale Brain Simulations** *18th IEEE International Symposium on Asynchronous Circuits and Systems (ASYNC)/6th ACM/IEEE International Symposium on Networks-on-Chip (NOCS)*
Boahen, K.
IEEE.2012: XIV-XIV
- **A Superposable Silicon Synapse with Programmable Reversal Potential** *34th Annual International Conference of the IEEE Engineering-in-Medicine-and-Biology-Society (EMBS)*
Benjamin, B. V., Arthur, J. V., Gao, P., Merolla, P., Boahen, K.
IEEE.2012: 771–774
- **Deep cerebellar neurons mirror the spinal cord's gain to implement an inverse controller** *BIOLOGICAL CYBERNETICS*
Alvarez-Icaza, R., Boahen, K.
2011; 105 (1): 29-40
- **Silicon-Neuron Design: A Dynamical Systems Approach** *IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS I-REGULAR PAPERS*
Arthur, J. V., Boahen, K. A.
2011; 58 (5): 1034-1043
- **Space coding by gamma oscillations in the barn owl optic tectum** *JOURNAL OF NEUROPHYSIOLOGY*
Sridharan, D., Boahen, K., Knudsen, E. I.
2011; 105 (5): 2005-2017
- **A Brain-Machine Interface Operating with a Real-Time Spiking Neural Network Control Algorithm.** *Advances in neural information processing systems*
Dethier, J., Nuyujukian, P., Eliasmith, C., Stewart, T., Ellassaad, S. A., Shenoy, K. V., Boahen, K.
2011; 2011: 2213-2221

- **Neuromorphic silicon neuron circuits** *FRONTIERS IN NEUROSCIENCE*
Indiveri, G., Linares-Barranco, B., Hamilton, T. J., van Schaik, A., Etienne-Cummings, R., Delbruck, T., Liu, S., Dudek, P., Hafliker, P., Renaud, S., Schemmel, J., Cauwenberghs, G., Arthur, et al
2011; 5
- **Spiking Neural Network Decoder for Brain-Machine Interfaces** *5th International IEEE Engineering-in-Medicine-and-Biology-Society (EMBS) Conference on Neural Engineering (NER)*
Dethier, J., Gilja, V., Nuyujukian, P., Ellassaad, S. A., Shenoy, K. V., Boahen, K.
IEEE.2011: 396–399
- **A 1-change-in-4 Delay-Insensitive Interchip Link** *International Symposium on Circuits and Systems Nano-Bio Circuit Fabrics and Systems (ISCAS 2010)*
Chandrasekaran, A., Boahen, K.
IEEE.2010: 3216–3219
- **A Silicon Cochlea With Active Coupling** *IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS*
Wen, B., Boahen, K.
2009; 3 (6): 444-455
- **Nonlinear Influence of T-Channels in an in silico Relay Neuron** *IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING*
Hynna, K. M., Boahen, K. A.
2009; 56 (6): 1734-1743
- **A Delay-Insensitive Address-Event Link** *15th IEEE International Symposium on Asynchronous Circuits and Systems*
Lin, J., Boahen, K.
IEEE.2009: 50–57
- **Synchrony in silicon: The gamma rhythm** *IEEE TRANSACTIONS ON NEURAL NETWORKS*
Arthur, J. V., Boahen, K. A.
2007; 18 (6): 1815-1825
- **Neurotech for neuroscience: Unifying concepts, organizing principles, and emerging tools** *JOURNAL OF NEUROSCIENCE*
Silver, R., Boahen, K., Grillner, S., Kopell, N., Olsen, K. L.
2007; 27 (44): 11807-11819
- **Expandable networks for neuromorphic chips (vol 54, pg 301, 2007)** *IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS I-REGULAR PAPERS*
Merolla, P. A., Arthur, J. V., Shi, B. E., Boahen, K. A.
2007; 54 (4): 925-926
- **Thermodynamically equivalent silicon models of voltage-dependent ion channels** *NEURAL COMPUTATION*
Hynna, K. M., Boahen, K.
2007; 19 (2): 327-350
- **Expandable networks for neuromorphic chips** *IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS I-REGULAR PAPERS*
Merolla, P. A., Arthur, J. V., Shi, B. E., Boahen, K. A.
2007; 54 (2): 301-311
- **Silicon neurons that burst when primed** *IEEE International Symposium on Circuits and Systems*
Hynna, K. M., Boahen, K.
IEEE.2007: 3363–3366
- **Silicon neurons that inhibit to synchronize** *IEEE International Symposium on Circuits and Systems*
Arthur, J. V., Boahen, K.
IEEE.2007: 1186–1186
- **A silicon retina that reproduces signals in the optic nerve** *JOURNAL OF NEURAL ENGINEERING*
Zaghloul, K. A., Boahen, K.
2006; 3 (4): 257-267
- **Neurogrid: emulating a million neurons in the cortex.** *Conference proceedings : ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Conference*

Boahen, K.
2006: 6702-?

- **Silicon neurons that inhibit to synchronize** 2006 *IEEE INTERNATIONAL SYMPOSIUM ON CIRCUITS AND SYSTEMS, VOLS 1-11, PROCEEDINGS*
Arthur, J. V., Boahen, K.
2006: 4807-?